International Journal Of Health, Engineering And Technology (IJHET) *E-ISSN 2829 – 8683*
Volume 4, Number 4, November 2025, *Page 888 – 895*
Email : editorijhess@gmail.com

The Role of Early Detection and Health Education in Breast Cancer Prevention: A Literature Review

Gresia Rosi Chofifah[1], Susianti[2], Ramadhana Komala[3], Indri Windarti[4]

Universitas Lampung, Indonesia
Email: gresiarosichofifah@gmail.com

Abstract

Breast cancer is one of the leading causes of death among women worldwide and poses a serious challenge in public health. Preventive efforts through early detection and health education are key strategies to reduce morbidity and mortality rates. This study is a literature review of five journals discussing the role of technology and educational interventions in breast cancer prevention. The method used is a narrative-descriptive approach by analyzing research findings from 2024–2025. The review results show that the application of machine learning and deep learning algorithms, such as Support Vector Machine (SVM), Logistic Regression, DenseNet, and Inception-ResNet-v2, can improve early detection accuracy to more than 90%. Meanwhile, health education particularly through training in breast self-examination (BSE) has proven effective in improving women's knowledge, attitudes, and behaviors toward early breast cancer detection. The synergy between technology and health education has shown a significantly positive impact on breast cancer prevention efforts. Therefore, integrating these two approaches needs to be strengthened in national health policies to achieve sustainable, community-based early detection..

Keywords: Early Detection, Prevention, BSE (Breast Self-Examination), Health Education, Breast Cancer

INTRODUCTION

Breast cancer is one of the non-communicable diseases that has become a leading cause of death among women worldwide. According to GLOBOCAN (2022), more than 670,000 deaths occur annually due to breast cancer, making it a serious global health threat (Andini & Akbar, 2025). In Indonesia, breast cancer ranks first among all types of cancer, with a total of 68,858 new cases recorded in 2020 and over 22,000 deaths caused by the disease (Rahmah & Safriana, 2024; Indriani *et al*., 2025). These figures highlight the urgent need for systematic efforts in prevention and early detection as key steps to reduce morbidity and mortality rates.

Early detection plays a vital role in improving patient survival rates. When breast cancer is detected at an early stage, the cure rate can exceed 90% (Mas'ud & Zeniarja, 2024). Unfortunately, most cases in Indonesia are diagnosed at an advanced stage due to low public awareness and limited knowledge about the importance of early screening (Rahmah & Safriana, 2024). This situation is worsened by the lack of comprehensive health education, particularly among women of reproductive age and adolescents. In fact, educational efforts have proven to be highly effective in improving awareness and preventive behavior related to breast cancer.

The simplest and most accessible early detection method is *SADARI* (self-breast examination). This method is recommended by the Indonesian Ministry of Health because it is easy to perform, requires no additional cost, and helps individuals recognize physical changes in the breast at an early stage (Indriani *et al*., 2025). A study by Rahmah and Safriana (2024) revealed that providing education about *SADARI* to women of reproductive age in Gresik significantly improved their knowledge, attitudes, and behaviors in detecting breast cancer.

Similar results were found in an educational activity conducted at Al-Ittihad High School in Cianjur, where 100% of participants understood the *SADARI* technique and committed to performing regular self-examinations after receiving counseling (Indriani *et al*., 2025). These findings indicate the strategic importance of health education in promoting early detection behavior.

In addition to educational approaches, technological advancement also plays a significant role in supporting early detection of breast cancer. Several studies have shown that the application of artificial intelligence (AI) and deep learning in mammogram image analysis can enhance diagnostic accuracy to over 90% (Desiani *et al*., 2025; Andini & Akbar, 2025). For instance, the Support Vector Machine (SVM) and Logistic Regression models have proven effective in classifying breast cancer cases with accuracy rates up to 98% (Desiani *et al*., 2025). Likewise, Convolutional Neural Network (CNN) architectures such as Inception-ResNet-v2 and DenseNet have been utilized to automatically and efficiently identify cancer image patterns (Mas'ud & Zeniarja, 2024). These technologies complement manual clinical examinations by enabling faster and more objective early detection.

However, the utilization of advanced technology will not be maximized without improving public health literacy. Education serves as a bridge between medical innovation and public understanding. Knowledge of risk factors, early symptoms, and detection techniques such as *SADARI* must be promoted from adolescence (Indriani *et al*., 2025). This aligns with the World Health Organization's (2023) assertion that educational interventions and health promotion are the most effective strategies to prevent non-communicable diseases, including breast cancer. Community-based education has also been proven to change negative perceptions and enhance women's motivation to perform routine breast examinations (Kholid, 2016; Nursalam, 2017 in Rahmah & Safriana, 2024).

Therefore, synergy between technology-based early detection and community-based health education is essential to reduce breast cancer incidence. Preventive efforts should not only focus on the medical aspect but also on empowering individuals to take responsibility for their own health. This literature review aims to examine various studies related to the effectiveness of early detection and the impact of health education in enhancing awareness and preventive behavior toward breast cancer in Indonesia. A collaborative approach that integrates technology, education, and health promotion is expected to become a sustainable strategy in reducing the burden of breast cancer in society.

RESEARCH METHODS

This literature review employs a narrative-descriptive approach aimed at identifying, analyzing, and synthesizing various research findings related to early detection and health education in breast cancer prevention. The review procedure was conducted systematically through three main stages: literature identification, article selection, and thematic analysis of relevant research findings.

The first stage, literature identification, involved exploring multiple scientific sources from nationally and internationally accredited Sinta journals published between 2024 and 2025. The search was conducted using keywords such as *"early detection of breast cancer," "BSE (Breast Self-Examination)," "health education,"* and *"deep learning for breast cancer classification."* Five journals that met the inclusion criteria were selected for further analysis, namely the studies by Desiani *et al*. (2025), Andini & Akbar (2025), Rahmah & Safriana (2024), Mas'ud & Zeniarja (2024), and Indriani *et al*. (2025).

The second stage focused on article selection and quality evaluation. Selected articles demonstrated direct relevance to the topic of breast cancer prevention through two primary

aspects: technological approaches for early detection and behavior-based health education. The inclusion criteria consisted of: (1) studies focusing on breast cancer detection or prevention; (2) the use of quantitative, experimental, or community service methods supported by empirical data; and (3) measurable outcomes, such as increased detection accuracy or improved preventive behavior. Conversely, opinion papers, studies without data, or those unrelated to the context of breast cancer prevention were excluded from analysis.

The third stage involved thematic analysis. Data from each study were extracted and categorized into two main themes: (a) the effectiveness of technology in early detection, including Support Vector Machine, CNN DenseNet, and Inception-ResNet-v2 (Desiani *et al*., 2025; Mas'ud & Zeniarja, 2024; Andini & Akbar, 2025); and (b) the impact of health education on improving knowledge and preventive behavior, particularly through the BSE method (Rahmah & Safriana, 2024; Indriani *et al*., 2025). Comparative analysis was applied to identify relationships between technological and educational interventions in supporting breast cancer prevention.

Through this approach, the review aims to provide a comprehensive understanding of how early detection and health education contribute to reducing the breast cancer burden and to serve as a foundation for future research and health policy recommendations.

RESULTS AND DISCUSSION

Research Results

Table 1.
Summary of Literature Review on Early Detection and Health Education in Breast Cancer Prevention

No	Researchers & Year	Research Title	Research Method	Key Findings and Results
1	Desiani, A., Zayanti, D. A., Ramayanti, I., Ramadhan, F. F., & Giovillando (2025)	Comparison of Support Vector Machine (SVM) and Logistic Regression Algorithms in Breast Cancer Classification	Quantitative-comparative research using data mining on the "Breast Cancer Dataset" from Kaggle (569 data, 31 attributes). Testing applied Percentage Split (80% training, 20% testing) and 10-Fold Cross Validation.	The SVM algorithm achieved the highest accuracy (98% with K-Fold, 96% with Percentage Split), while Logistic Regression reached 97% and 96%. SVM showed superior stability and generalization; LR was more efficient for large datasets. SVM-based CAD systems are recommended for rapid and accurate clinical screening.
2	Andini, K. V., & Akbar, H. (2025)	Comparison of Inception-v3 and Inception-ResNet-v2 on Mammogram Images for Early Breast Cancer Detection	Quantitative experiment using a CNN-based deep learning approach with 745 mammogram images (125 cancer, 620 non-cancer). Dataset split 80:20 for training and validation	The Inception-ResNet-v2 model achieved 95.30% accuracy, 95.39% precision, 95.30% recall, and 95.34% F1-score. The ResNet architecture excelled in extracting complex features with a 5.13-minute training time.

			using transfer learning with ImageNet.	Effective for rapid and accurate detection in healthcare facilities.
3	Rahmah, F., & Safriana, R. E. (2024)	The Effect of Breast Self-Examination Education on Early Detection Behavior of Breast Cancer among Women of Reproductive Age in Sukomulyo Village, Gresik	Quasi-experimental design using a one-group pre-test and post-test on 48 women of reproductive age. Data analyzed with paired sample t-test.	p-value = 0.000 (<0.05) indicates a significant increase in knowledge and early detection behavior. Knowledge scores rose from 46.92 to 84.50. Demonstrative education effectively changed preventive behavior toward breast cancer.
4	Mas'ud, R. A., & Zeniarja, J. (2024)	Optimization of Convolutional Neural Networks (CNN) for Breast Cancer Detection Using DenseNet Architecture	Quantitative experiment using deep learning with the "Breast Histopathology Images" dataset (90,000 images). CNN model optimized with DenseNet architecture.	DenseNet achieved 92% accuracy in classifying breast cancer images. The model enhanced subtle pattern recognition and accelerated learning processes. CNN proved effective in assisting visual diagnosis of small tumor masses.
5	Indriani, T. D., Aliansy, D., & Febrianingsih, D. A. (2025)	Early Breast Cancer Prevention through Breast Self-Examination (BSE) among Female Students at SMA Al-Ittihad, Cianjur	Community service activity with participatory-educational methods for 47 female students through pre-test, counseling, BSE demonstration, and post-test.	Before education, only 4% of participants recognized early signs of breast cancer. After education, 100% could perform BSE correctly, and 98% knew the appropriate timing. Practice-based education effectively raised adolescent awareness of early detection.

The findings from the five analyzed studies reveal two major directions of research contributions to breast cancer prevention: early detection technology and health education interventions. Within the early detection technology group, studies by Desiani *et al*. (2025), Andini & Akbar (2025), and Mas'ud & Zeniarja (2024) focused on developing medical image classification methods using artificial intelligence algorithms. Desiani *et al*. (2025) demonstrated that the Support Vector Machine (SVM) and Logistic Regression algorithms were capable of identifying breast cancer types with accuracies exceeding 95%. Meanwhile, the Inception-ResNet-v2 model examined by Andini & Akbar (2025) achieved 95.30% accuracy with relatively short training time, highlighting the efficiency of deep learning models in automatically detecting cancer image patterns. Similarly, Mas'ud & Zeniarja (2024) reported that the DenseNet architecture successfully detected histopathological images with 92% accuracy. Collectively, these results indicate that machine learning and deep learning technologies hold substantial potential for supporting early breast cancer diagnosis that is rapid, objective, and highly accurate.

On the other hand, research based on health education, particularly the studies by Rahmah & Safriana (2024) and Indriani *et al*. (2025) demonstrated the influence of knowledge dissemination and *SADARI* (breast self-examination) training on preventive behavioral changes.

Education effectively improved women's awareness, skills, and intention to perform early detection independently. The significant statistical value ($p < 0.05$) in Rahmah & Safriana's (2024) study confirmed a real behavioral change, while outreach activities by Indriani *et al*. (2025) led to a 100% increase in understanding among adolescent girls. Overall, the reviewed literature shows that both technology-based and education-based approaches provide complementary contributions to breast cancer prevention: technology enables faster and more objective diagnosis, while education strengthens public awareness and preventive action.

Discussion

Breast cancer is a global health problem that continues to increase every year and remains a leading cause of death among women. Literature reviews indicate that prevention and control efforts can be pursued through two main approaches, namely technology-based early detection and community health education. These two approaches are inseparable because they complement each other. Technology accelerates diagnosis and improves accuracy, while education builds awareness and preventive behavior at both individual and community levels.

1. Early Detection Based on Technology

The advancement of artificial intelligence (AI) and machine learning technologies has opened vast opportunities in the medical field, particularly in the early detection of breast cancer. Research by Desiani *et al*. (2025) showed that the Support Vector Machine (SVM) and Logistic Regression (LR) algorithms can classify types of breast cancer with an accuracy rate above 95 percent. These results indicate that computational methods can serve as Computer-Aided Diagnosis (CAD) tools, assisting doctors in analyzing medical imaging data more objectively. In addition, the use of the K-Fold Cross Validation method enhances model reliability by minimizing overfitting and producing consistent outcomes.

Similarly, the study by Andini and Akbar (2025) using the Inception-ResNet-v2 architecture demonstrated the effectiveness of deep learning in identifying mammogram images with 95.3 percent accuracy. This model can recognize complex patterns in medical images that are often invisible to the human eye. Such capability positions deep learning as a promising diagnostic tool, especially for large-scale screening in hospitals or health centers. Mas'ud and Zeniarja (2024) reinforced these findings with 92 percent accuracy using the DenseNet architecture, which is more efficient in processing large-scale data. This architecture effectively addresses the vanishing gradient issue and accelerates model training without compromising accuracy.

The consistency of these findings demonstrates that AI technology is not only a diagnostic aid but also an early detection tool that can reduce the risk of delayed treatment. Integrating AI-based systems with medical services can accelerate clinical decision-making, improve screening quality, and reduce hospital operational costs. Nevertheless, several challenges remain, including limited human resources capable of operating AI systems, the availability of high-quality data, and ethical considerations related to the use of patients' medical information.

2. Health Education as a Prevention Strategy

In addition to technological advancements, the literature reveals that health education significantly influences early detection behaviors within communities. The study by Rahmah and Safriana (2024) demonstrated that providing education about breast self-examination (BSE) substantially improved the knowledge, attitudes, and behaviors of women of reproductive age,

with a p-value of 0.000. This finding indicates that health education can transform passive behavior into proactive self-examination practices. Moreover, education helps reduce stigma and fear associated with breast cancer screening, which have long been major barriers to early detection efforts.

Indriani *et al*. (2025) expanded on these findings by focusing on adolescent girls in schools. After receiving counseling and BSE demonstrations, 100% of participants understood the correct examination procedures, and 98% knew the proper timing. Early education among adolescents has long-term benefits, fostering health awareness and early detection habits from a young age. These findings align with the World Health Organization's (2023) statement that education-based health promotion is the most effective strategy for preventing noncommunicable diseases, including breast cancer.

Such educational initiatives can be strengthened through community-based education approaches, where healthcare professionals collaborate with local communities, schools, and religious institutions to improve knowledge and skills related to early detection. The demonstration method used in both studies proved highly effective, as it provided hands-on experience and reinforced practical understanding. Consistent with Kholid's (2016) theory, knowledge serves as a key cognitive component that can influence changes in individual attitudes and health behaviors.

3. Integration of Technology and Health Education

Technological and educational approaches hold great potential when strategically integrated. Early detection technologies powered by artificial intelligence can be used not only by medical professionals but also as digital educational tools for the public. For instance, mobile applications based on machine learning can be developed to provide simulations of breast self-examinations, self-assessment guides, and preliminary analyses of user-submitted images. This enables health education to become more interactive and continuous.

From a policy perspective, synergy between technological innovation and health promotion is essential to strengthen the national cancer prevention system. The government can play a role by expanding access to mammography, reinforcing breast self-examination campaigns, and supporting research on AI applications in primary health care. A "community-based early detection" program that combines education with simple or digital diagnostic tools could effectively reduce breast cancer mortality, particularly in areas with limited medical facilities.

4. Implications and Future Research Directions

This review shows that the success of breast cancer prevention depends on multidisciplinary collaboration among medical, information technology, and public health education fields. Future research should focus on developing integrative models that combine deep learning technology with behavioral approaches in public health. It is also essential to evaluate the long term effectiveness of both conventional and digital educational interventions in improving early detection behaviors within communities. Therefore, it can be concluded that effective breast cancer prevention relies not only on technological capability to detect disease but also on public readiness to understand and adopt healthy lifestyles. The combination of early detection and health education provides a comprehensive strategy that can sustainably reduce the incidence and mortality rates of breast cancer.

CONCLUSION

The literature review results indicate that early detection and health education play complementary roles in breast cancer prevention efforts. Technological approaches using machine learning and deep learning algorithms such as SVM, Logistic Regression, Inception ResNet v2, and DenseNet have proven to enhance the accuracy of breast cancer image classification to more than 90 percent. This technology contributes to faster diagnosis, minimizes the risk of manual interpretation errors, and improves the efficiency of screening processes. On the other hand, health education interventions through counseling and training in breast self examination have shown significant improvements in women's knowledge, attitudes, and behaviors toward early detection. Participatory education, particularly among adolescents and women of reproductive age, fosters a strong preventive awareness to detect cancer at early stage.

Therefore, breast cancer prevention cannot rely on a single approach but must integrate technological innovation with community-based health education. The government and health professionals are encouraged to strengthen the synergy between digital health service programs and accessible public educational campaigns. Furthermore, future research should develop an integrative model that combines AI based automatic detection systems with interactive educational applications so that early detection can be performed independently, effectively, and sustainably. This effort is expected to reduce the incidence and mortality rates of breast cancer in Indonesia while improving women's quality of life through better health awareness.

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